Kakapo

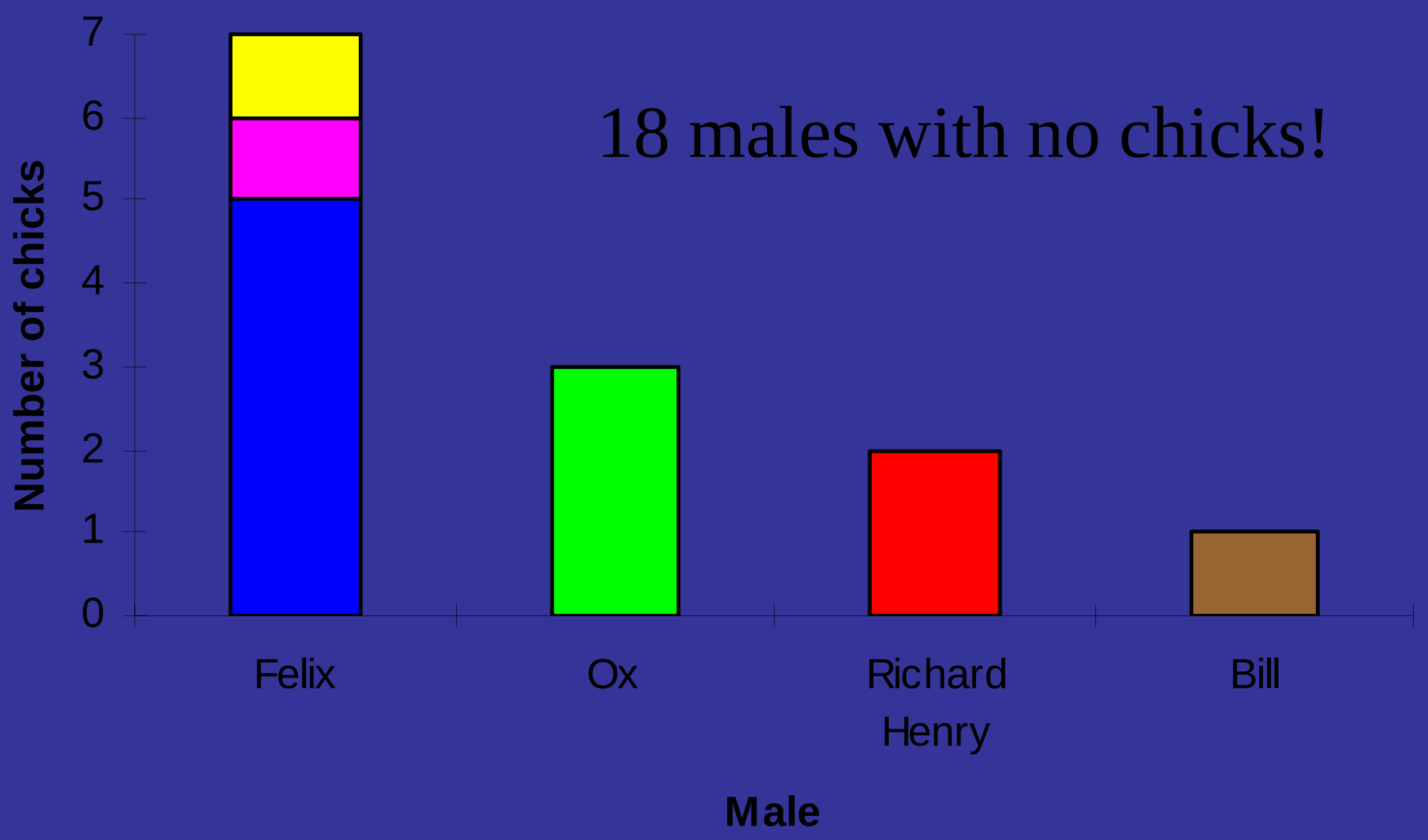
Felix




The Department of Conservation (DOC) has been managing the last 50 or so kakapos. Thirteen chicks were produced between 1992 and 1998.

Genetic analysis revealed that over half of the 13 chicks were fathered by a single male (Felix) and 18 males did not father ANY chicks at all!

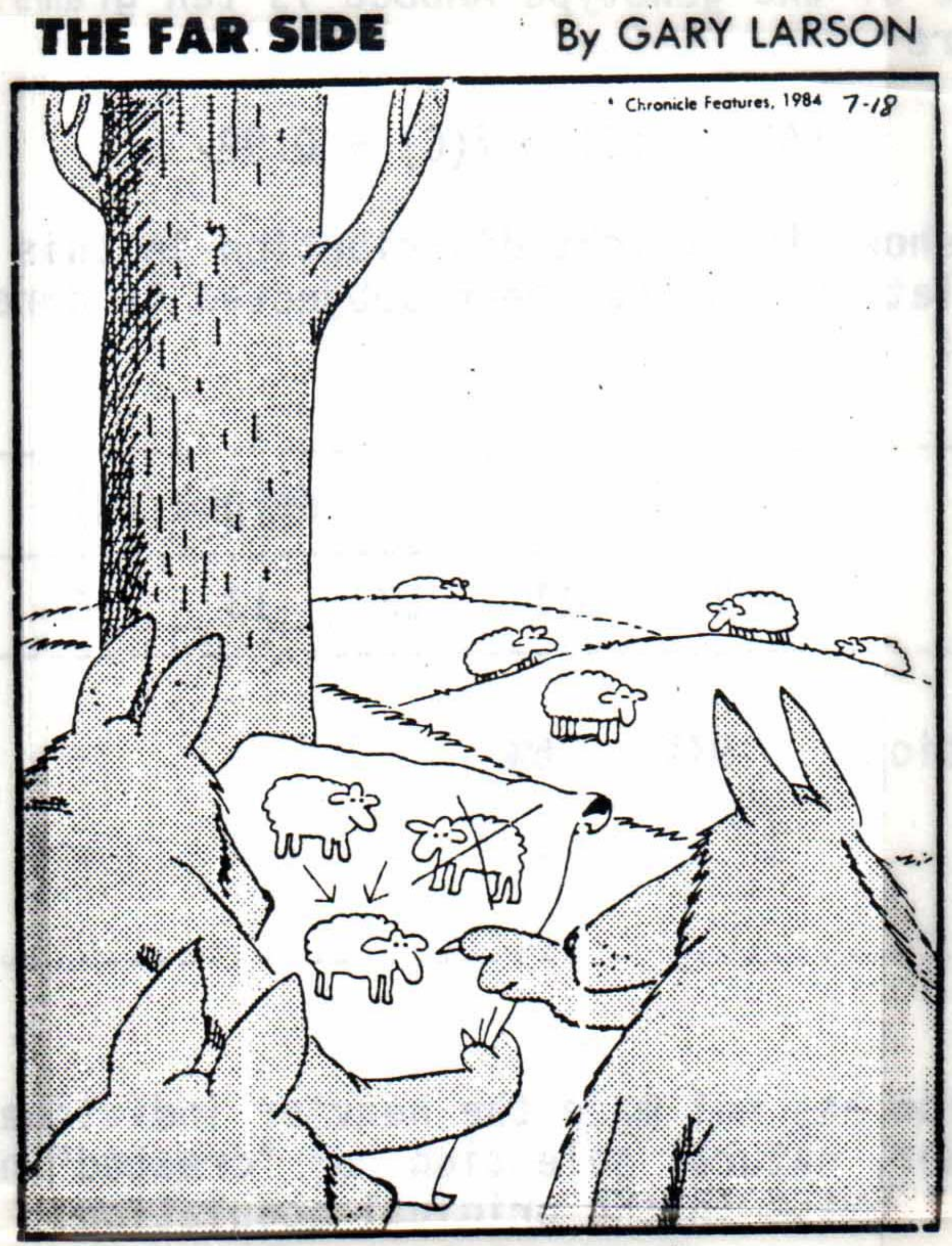
(Data from Bruce Robertson.)



Therefore, genetic variation is being lost in kakapo much faster than would be predicted for a population of 50 birds because of the reproductive success of some males.

What should be done?

Should Felix be voted off of the island?



Natural selection at work

CHAPTER 8

NATURAL SELECTION

I have called this principle, by which each slight variation, if useful, is preserved, by the term Natural Selection.

Charles Darwin

Then comes the question, Why do some live rather than others? If all the individuals of each species were exactly alike in every respect, we could only say it is a matter of chance. But they are not alike. We find that they vary in many different ways. Some are stronger, some swifter, some hardier in constitution, some more cunning.

Alfred Russel Wallace (1889)

Assumptions of Hardy-Weinberg model

1. Random mating.

2. No mutation.

3. Large (infinite) population size.

4. No differential survival or reproduction
   (i.e., no natural selection).

5. No immigration

NATURAL SELECTION – the short-form

(1) Variation exists.

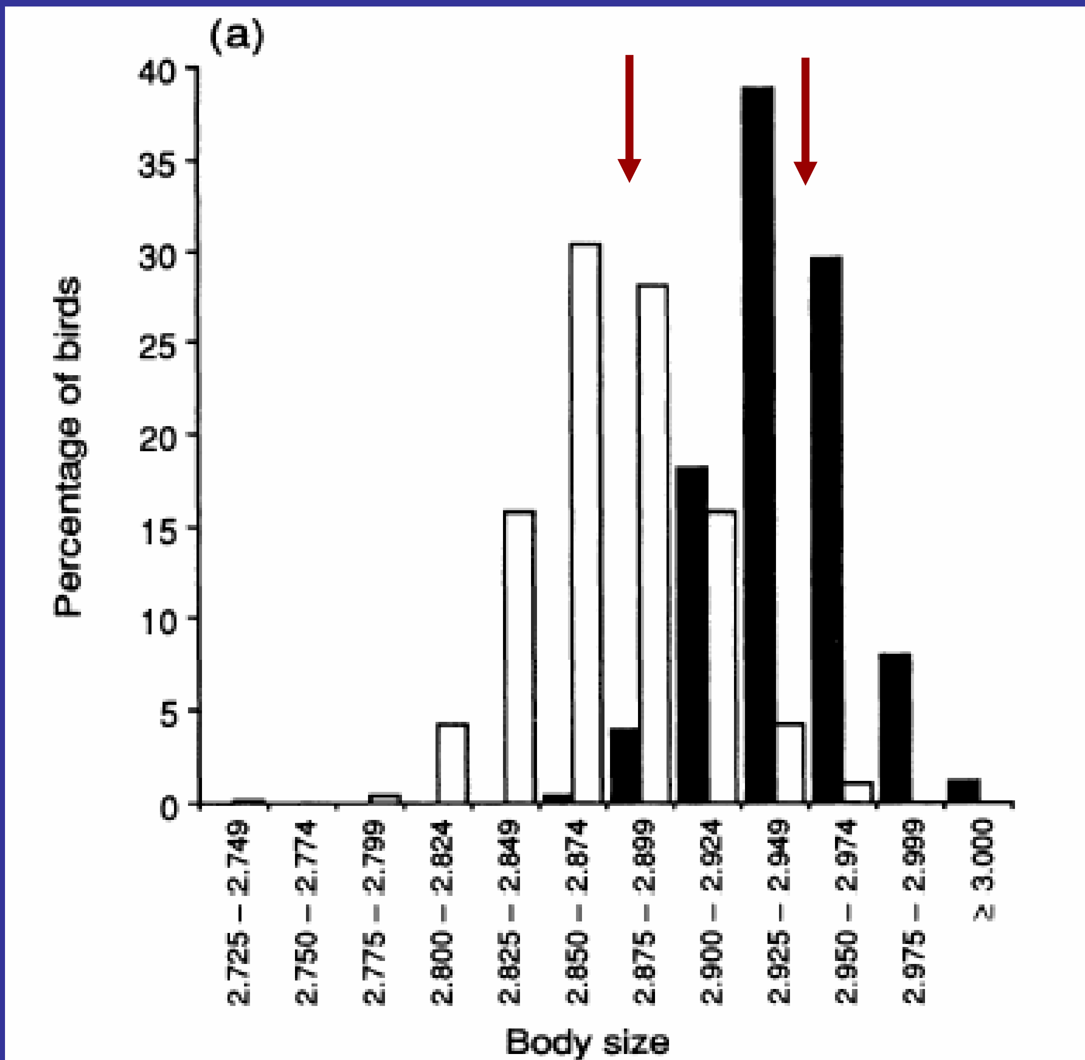
(2) Inheritance of variation.

(3) Differential survival or reproductive success.

OUTCOME: Those alleles associated with greater survival or reproductive success will increase in frequency the next generation.

INTENSE NATURAL SELECTION ON BODY SIZE AND WING AND TAIL ASYMMETRY IN CLIFF SWALLOWS DURING SEVERE WEATHER

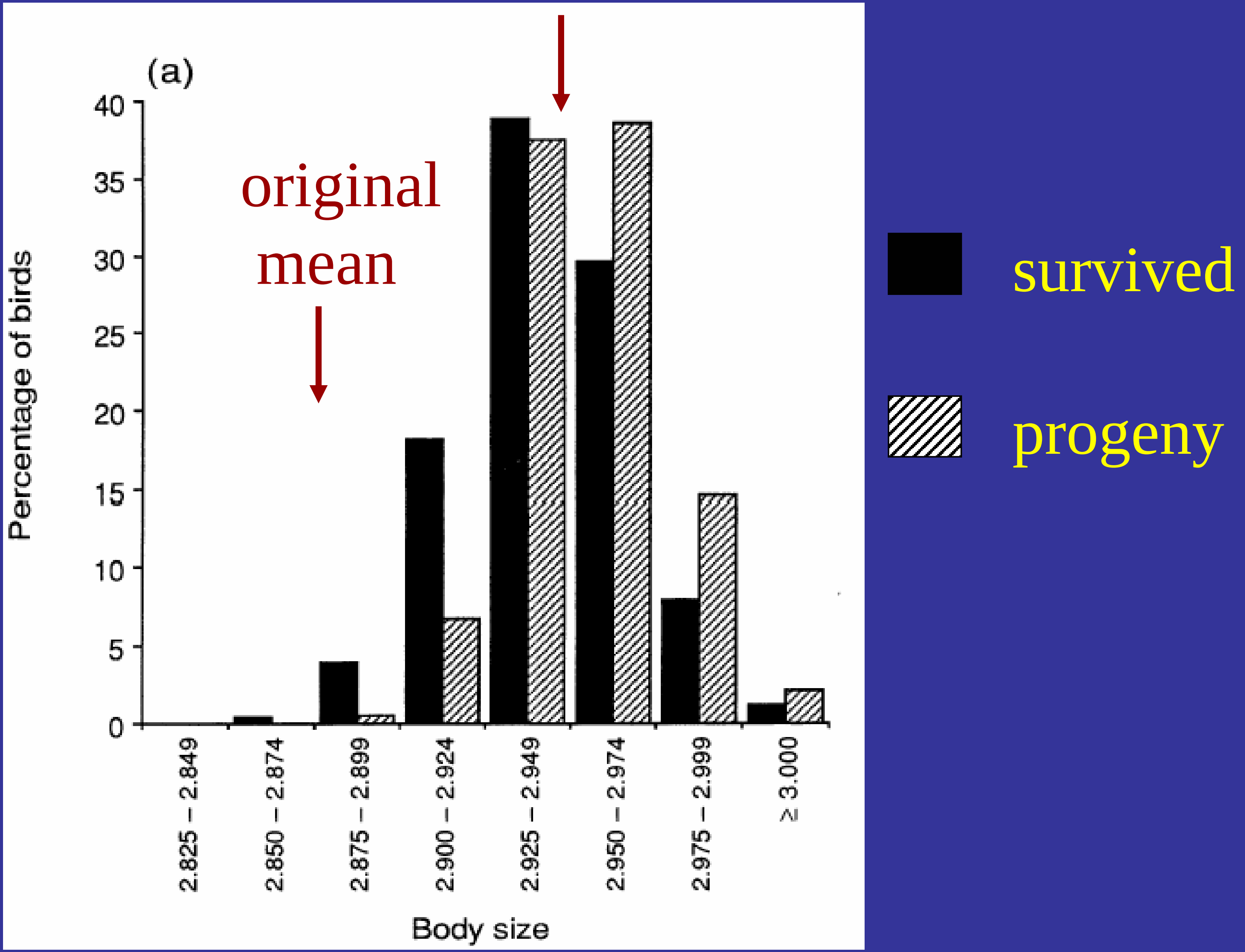
CHARLES R. BROWN[1] AND MARY BOMBERGER BROWN
Department of Biological Sciences, University of Tulsa, 600 South College Avenue, Tulsa, Oklahoma 74104



survived

died

next generation



Super bucks: Game-farm offspring used to beef up wild herds

By RAY SASSER
Dallas Morning News

DALLAS – It was 10 years ago this month that a George Barnett deer photo appeared on a newspaper's pages with the question: "Is this the biggest buck in Texas?"

The buck in question was a wild deer at Hagerman National Wildlife Refuge. Its shed antlers scored 236 non-typical Boone and Crockett points. B&C generally is the accepted scoring system by which deer are judged.

Barnett, a career counselor at Richland College and a self-professed white-tailed deer addict, recently photographed another buck. This one, Barnett believes, may be the biggest live buck in the U.S.

It's not a wild buck. It recently was

points, so his net score is probably 295 B&C non-typical.

Only four bucks that scored 300 B&C or higher ever have been reported. The world record is 333 and 7/8ths, a buck found dead near St. Louis, Mo., in 1981.

"Since I started photographing brood bucks nine years ago, more and more big deer have started showing up," Barnett said. "A brood buck that scored above 200 B&C used to be a big deal. Whitetail Genetic Research Institute has five bucks that score over 200. The bucks are getting bigger."

Big bucks mean big bucks. Barnett, who often puts buyers in touch with deer breeders, said exceptional brood bucks routinely sell for $20,000 to $30,000.

The buck "30-30" sold for $150,000, probably the all-time market price for a

The giant non-typical buck is called "30-30," but he easily could be named "30-30-30." The deer has 32 points and measures 30 inches of inside spread, and both beams are longer than 30 inches. The buck's greatest outside spread is 38 inches.

produced by these programs are so valuabl[e] they may not show up in a hunting situatio[n] for two or three generations.

Carefully documented breeding programs eventually may solve the puzzle

Generation t — Genotype frequencies at birth

↓ *Differential survival*

Genotype frequencies in adults

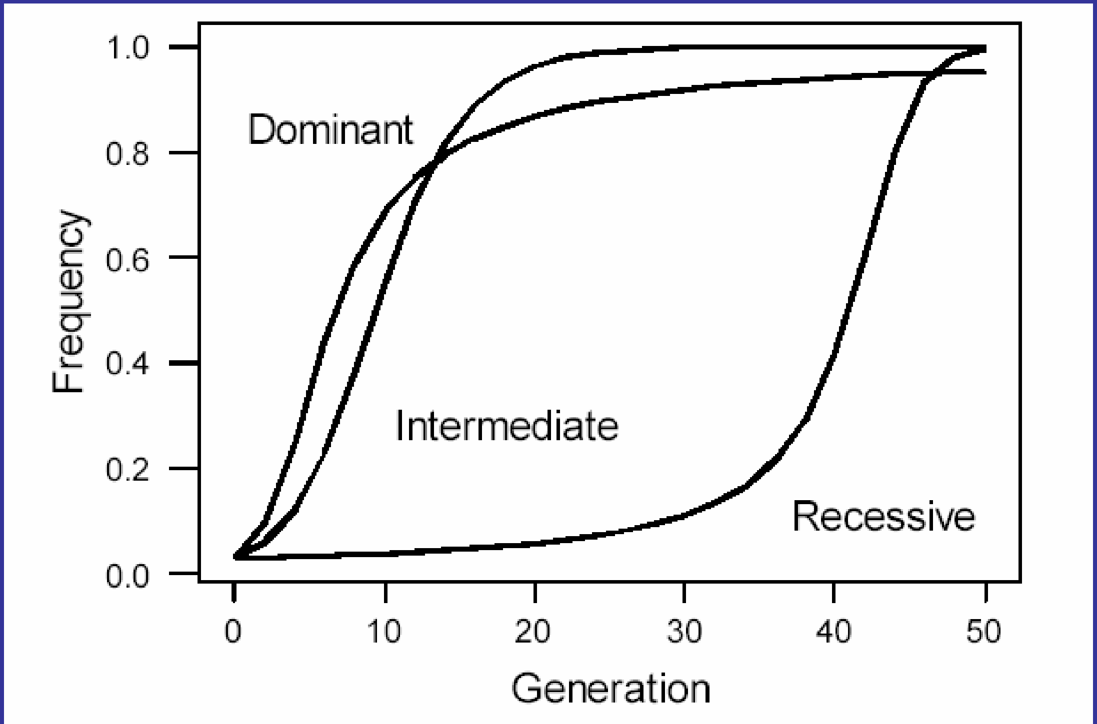
↓ *Differential fertility*

Frequencies of matings

↓

Generation $t + 1$ — Genotype frequencies at birth

Directional Selection for *A1* allele



	A1A1	*A1A2*	*A2A2*
Dominant	1.00	1.00	0.50
Intermed	1.00	0.75	0.50
Recessive	1.00	0.50	0.50

Heterozygous advantage

(overdominance)

$$w_{11} < w_{12} > w_{22}$$

36 hours at 27C



	Genotype		
	100/100	*100/80*	*80/80*
Alive	48	90	12
Dead	47	53	27
Total	95	143	39
Relative survival	0.803 <	1.000 >	0.490



Balancing Selection at the Prion Protein Gene Consistent with Prehistoric Kurulike Epidemics

Kuru is a prion disease transmitted during cannibalistic feasts in people of the Fore linguistic group of the Papua New Guinea Highlands. Genotypes at a prion protein gene (*PRNP*) confer resistance to prion diseases. Strong natural selection has eliminated homozygous genotypes in female survivors of the kuru epidemic who had multiple exposures at mortuary feasts.

Selection at a prion protein gene (*PRNP*)

	MM	*MV*	*VV*
Unexposed women	31	72	37
Exposed women (>50 years)	4	23	3
Relative survival	0.40	1.00	0.25

Frequency-dependent Selection

Fitness sometimes varies as a function of allele frequencies. That is, the fitness of a particular genotype changes as its frequency in the population changes. Frequency-dependent selection will maintain genetic variation whenever a rare allele has a selective advantage.

Frequency-dependent Selection

Rare male mating advantage.

Predator avoidance. Rare phenotypes are often less preyed upon and, thus, have greater fitness.

Disease resistance. Pathogens are selected to be most effective against the common types in their host population. Thus, rare host genotypes tend to be more resistant to a variety of pathogens.

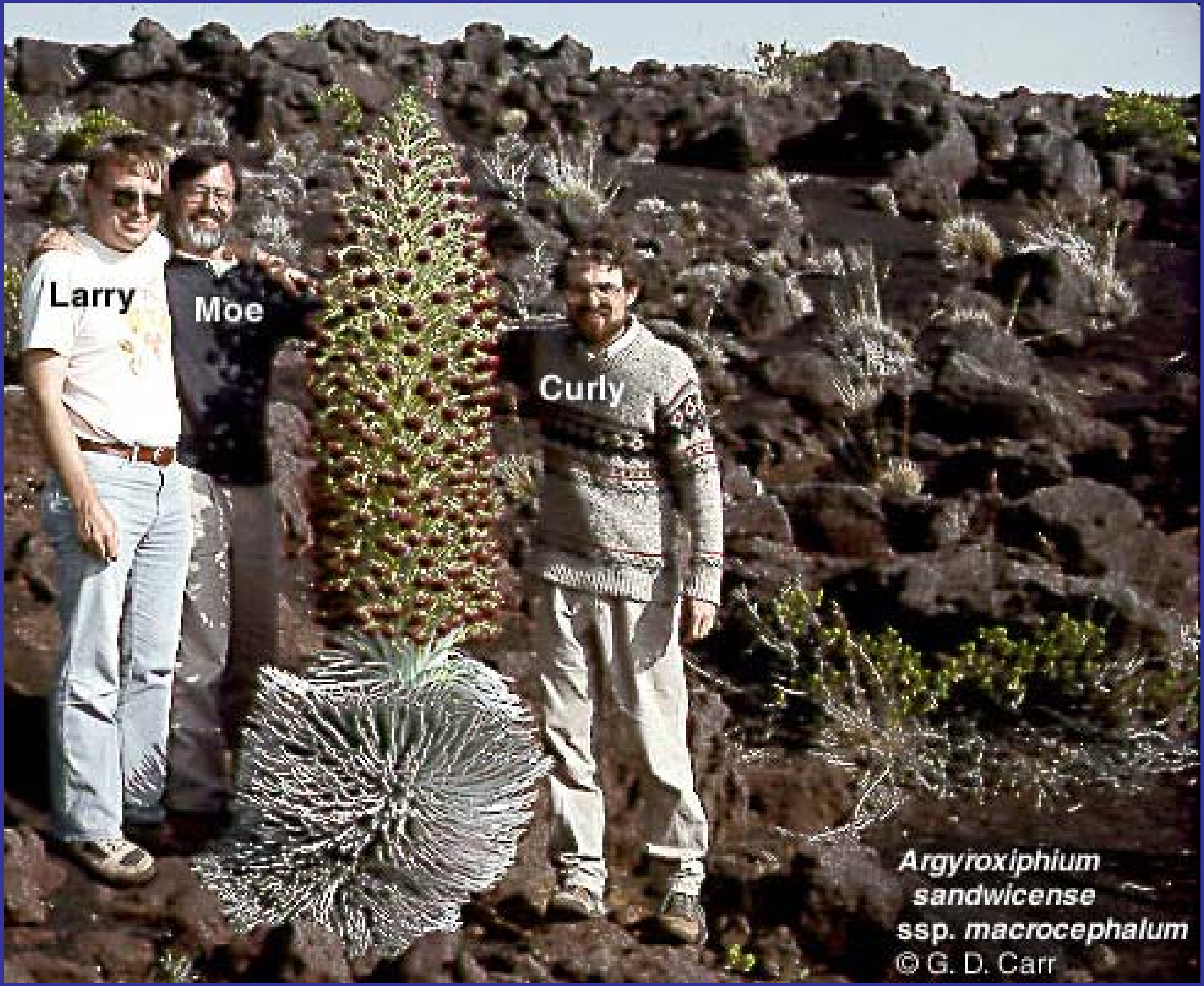
Ecological competition. Different genotypes sometimes use different resources. Rare genotypes that different resources will have an advantage.

Frequency-dependent selection will act to maintain genetic variation if rare genotypes have a selective advantage.

Parental Genotypes		Progeny Frequencies		
Ovule	Pollen	S_1S_2	S_1S_3	S_2S_3
S_1S_2	S_3	0.00	0.50	0.50
S_1S_3	S_2	0.50	0.00	0.50
S_2S_3	S_1	0.50	0.50	0.00

Self-incompatibility locus in plants

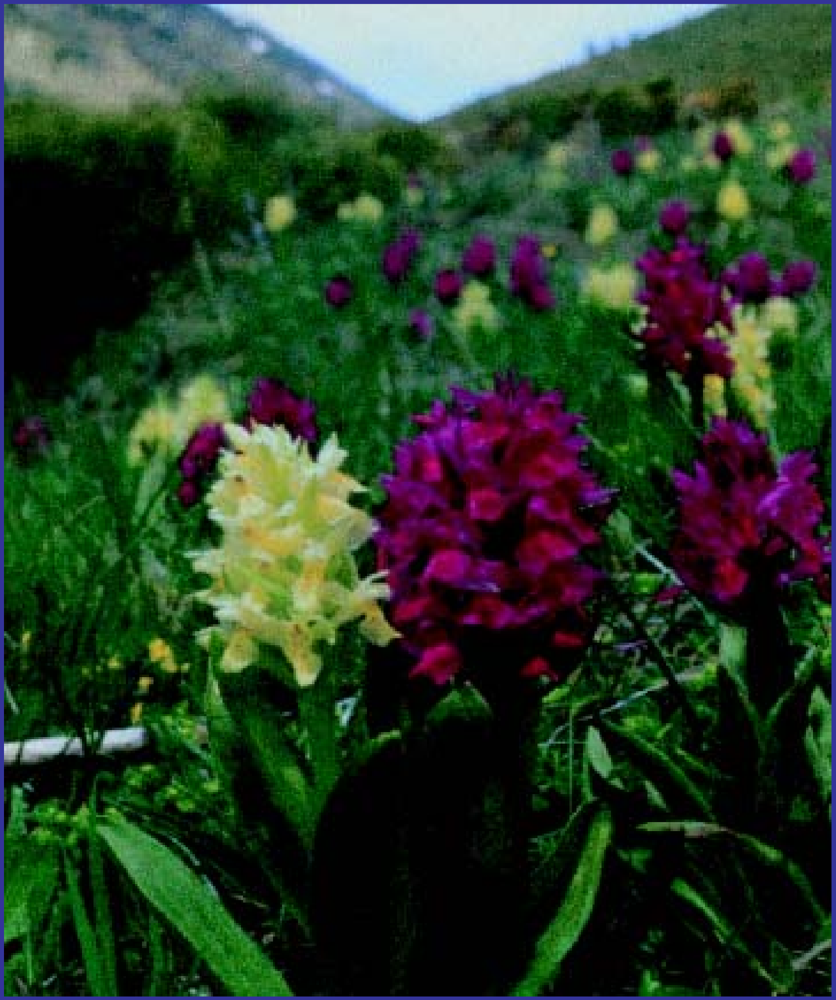
The last Illinois population of the lakeside daisy was effectively extinct even though it consisted of approximately 30 individuals because all plants apparently belonged to the same mating type (Demauro 1993).

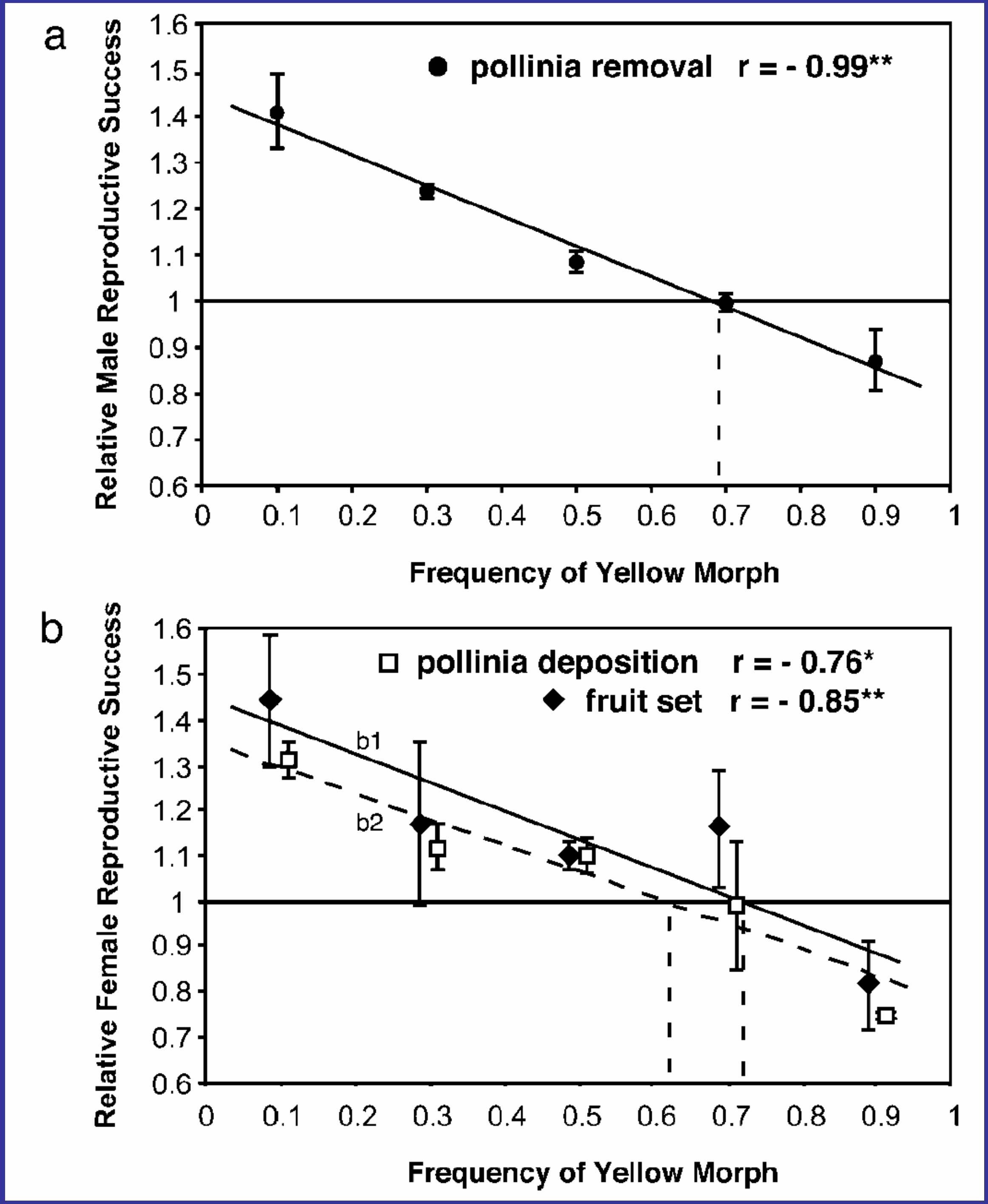

Larry
Moe
Curly
Argyroxiphium
sandwicense
ssp. macrocephalum
© G. D. Carr

Negative frequency-dependent selection maintains a dramatic flower color polymorphism in the rewardless orchid *Dactylorhiza sambucina* (L.) Soò

Luc D. B. Gigord*, Mark R. Macnair, and Ann Smithson

PNAS 98: 6253-6255 (2001)





a
pollinia removal r = - 0.99**
Relative Male Reproductive Success
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
Frequency of Yellow Morph
b
pollinia deposition r = - 0.76*
fruit set r = - 0.85**
b1
b2
Relative Female Reproductive Success
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
Frequency of Yellow Morph

Frequency-Dependent Natural Selection in the Handedness of Scale-Eating Cichlid Fish

Michio Hori

Frequency-dependent natural selection has been cited as a mechanism for maintaining polymorphisms in biological populations, although the process has not been documented conclusively in field study. Here, it is demonstrated that the direction of mouth-opening (either left-handed or right-handed) in scale-eating cichlid fish of Lake Tanganyika is determined on the basis of simple genetics and that the abundance of individuals with left- or right-handedness depends on frequency-dependent natural selection. Attacking from behind, right-handed individuals snatched scales from the prey's left flank and left-handed ones from the right flank. Within a given population, the frequency of the two phenotypes oscillated around unity. This phenomenon was effected through frequency-dependent selection exerted by the prey's alertness. Thus, individuals of the rare phenotype had more success as predators than those of the more common phenotype.

Science 260: 216-219. 1993.

Natural selection vs. genetic drift

Natural selection in small populations

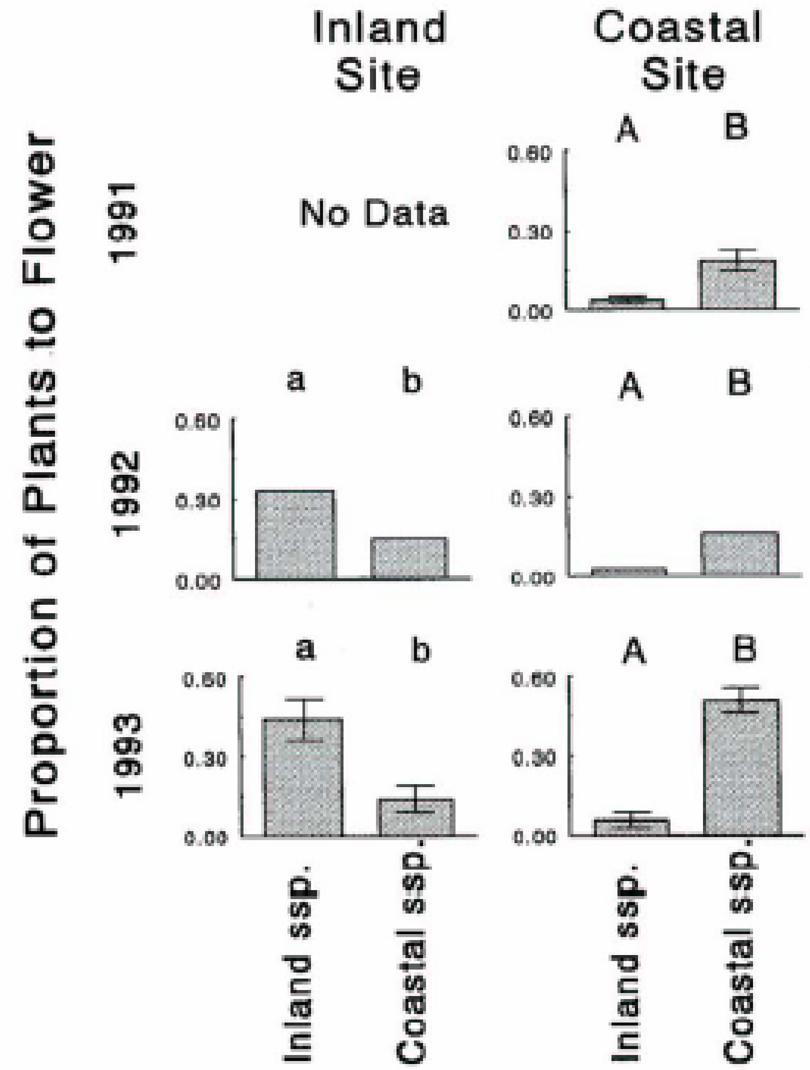
Natural selection is not effective in small populations because random changes caused by drift can swamp effects of differential fitness.

Approximate rule-of-thumb:

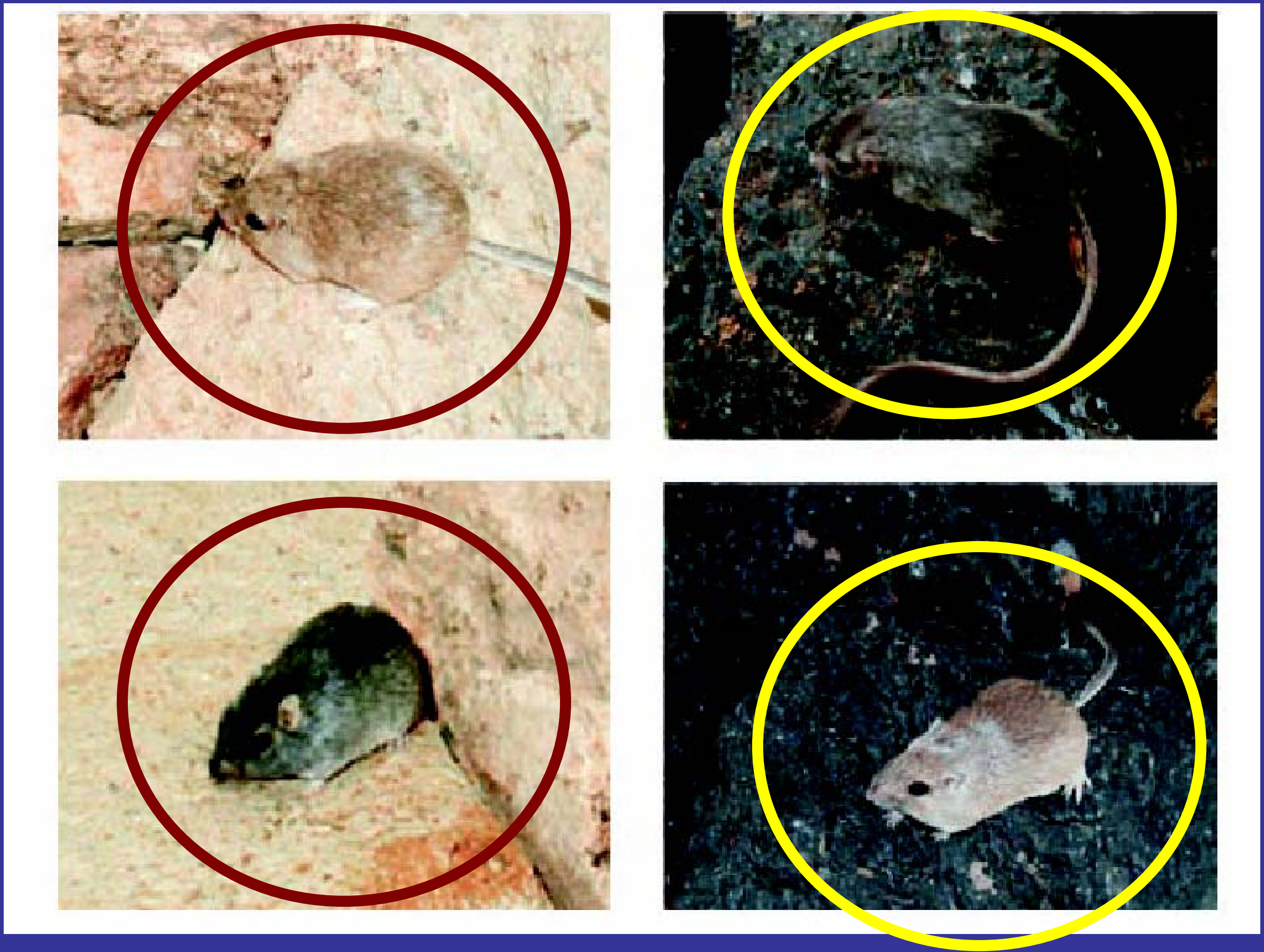
If $N_e s < 1$ then drift "wins".

Local adaptation

Globe gilia



Local adaptation



The genetic basis of adaptive melanism in pocket mice

Michael W. Nachman*, Hopi E. Hoekstra, and Susan L. D'Agostino

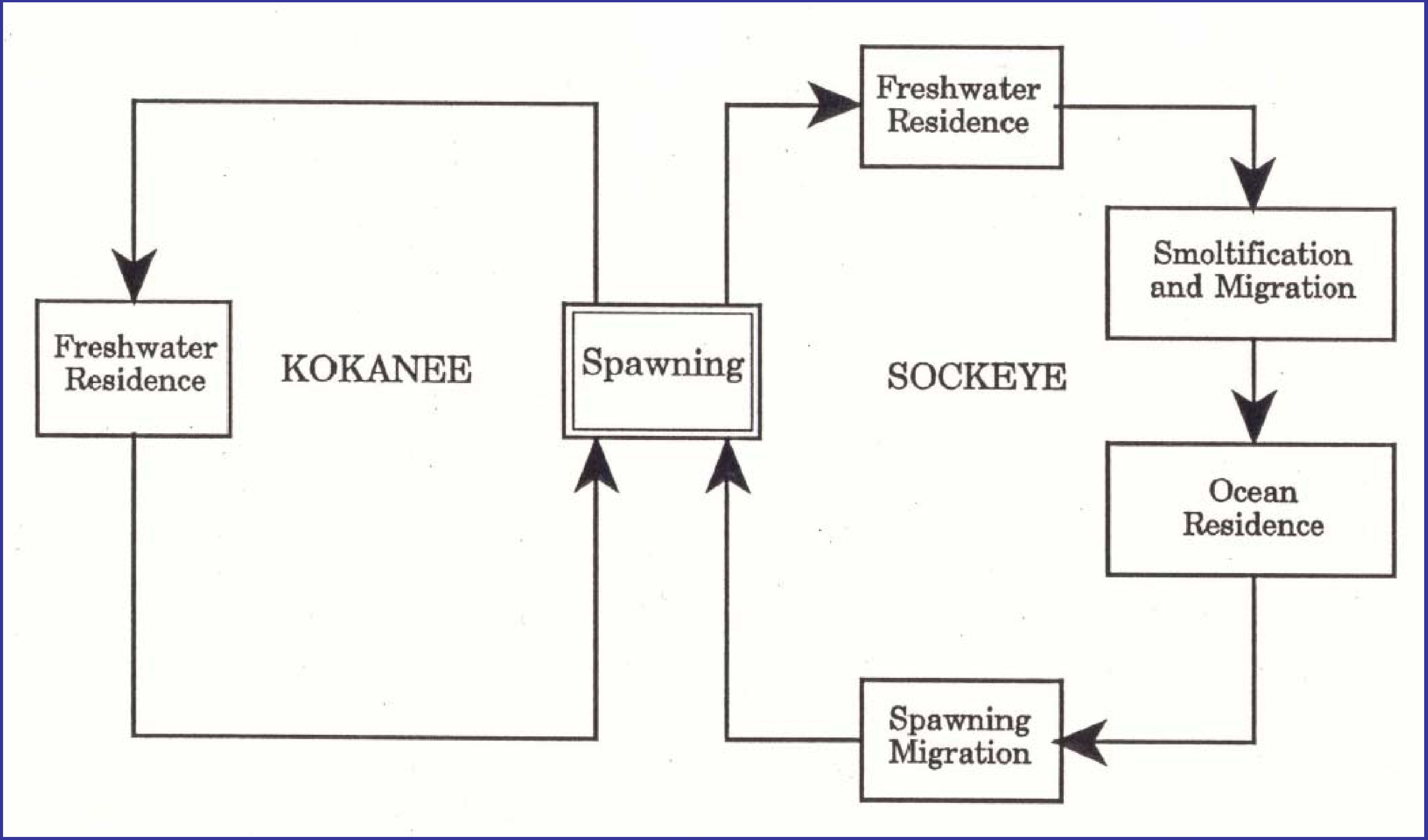
Department of Ecology and Evolutionary Biology, Biosciences West Building, University of Arizona, Tucson, AZ 85721

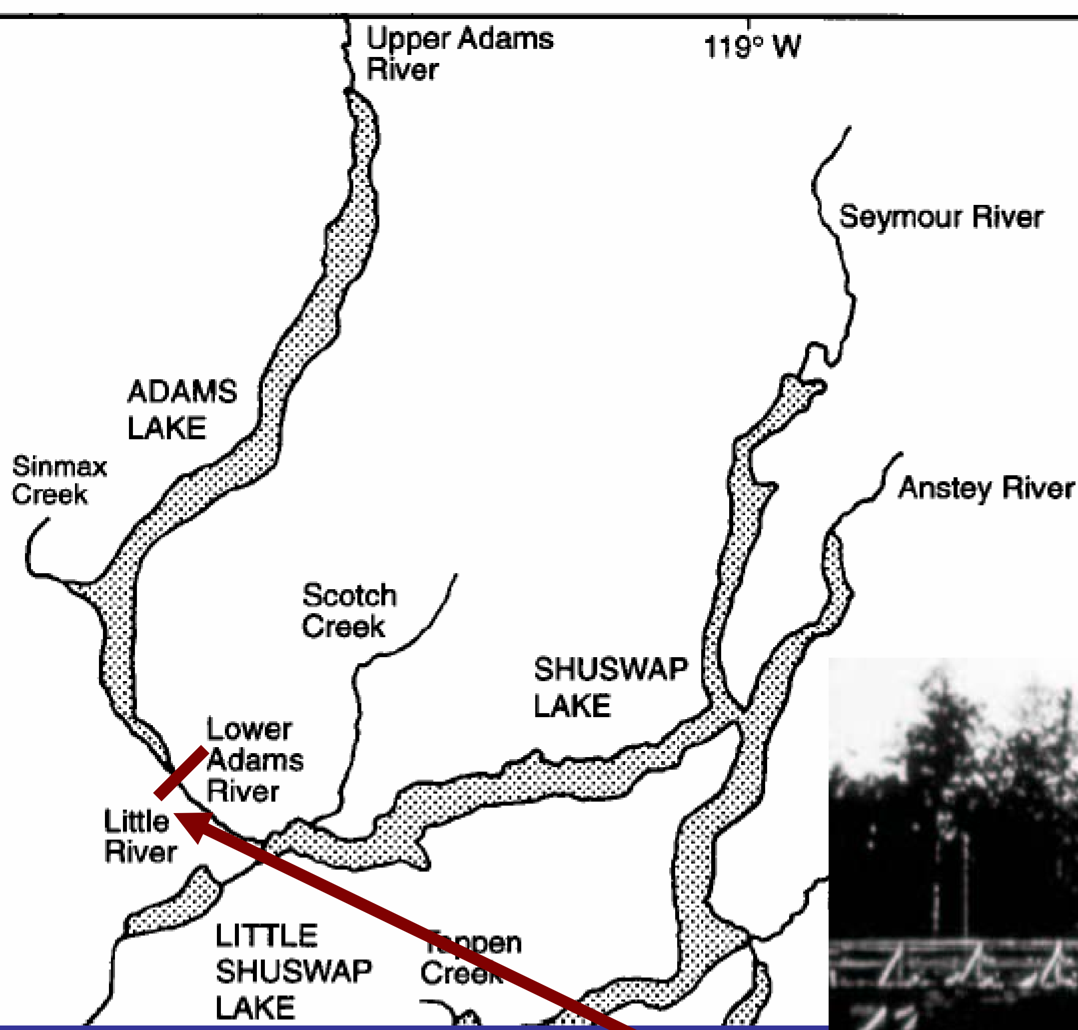
How important are local adaptations for restoration?

For example, can extirpated populations be reestablished?

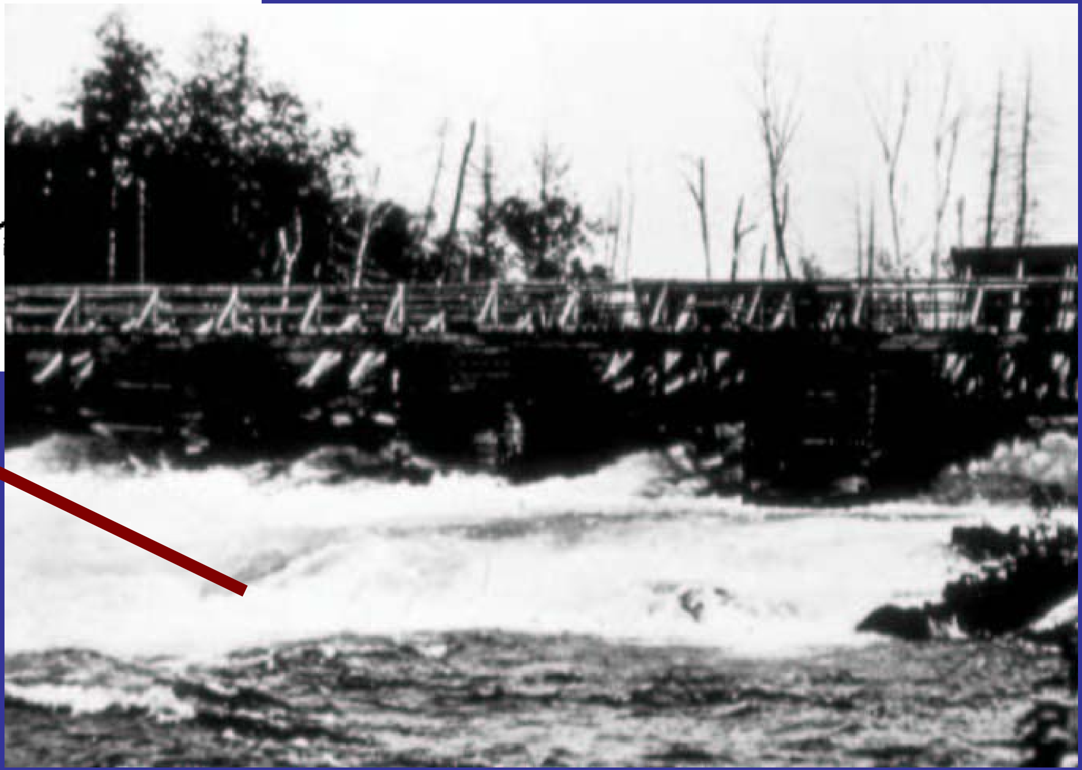
Sockeye salmon

Sockeye salmon life history





Upper Adams River sockeye salmon (~6,000,000 per year)



Logging dam

(1908-1921)

Episodic selection: local adaptations essential during periodic episodes of extreme environmental conditions (e.g., winter storms, drought, or fire).

Populations may experience "ecological crunches" in variable climates, nullifying the assumptions of competition theory and limiting the usefulness of short-term studies of population patterns

Weins, J. A. 1977. On competition and variable environments. American Scientist 65:591-597.

Cherry orchard

After severe winter storm

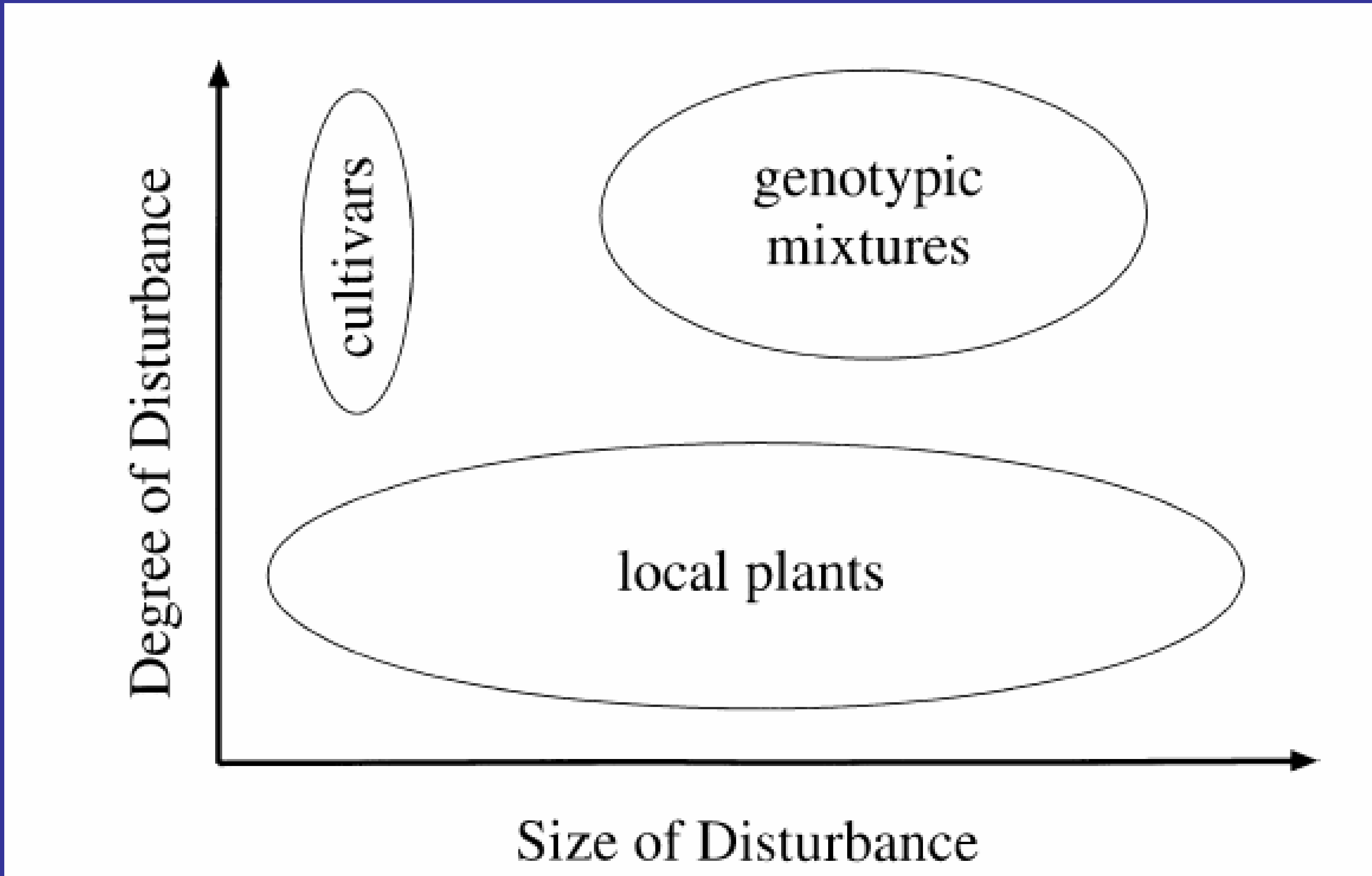
Deadhorse Creek

Before fire

After fire

Ecological Genetics and the Restoration of Plant Communities: Mix or Match?

Peter Lesica[1]
Fred W. Allendorf[1]


cultivars
genotypic mixtures
local plants
Degree of Disturbance
Size of Disturbance